The merged surface and satellite observed cloud, radiation, and precipitation data sets

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UND

NASA ENERGY AND WATER CYCLE STUDY

NEWS

Goals

1) Provide completed ground-based observations of clouds, radiation and precipitations from DOE ARM program and other sources for NEWS community.

2) These ground-based observations can serve as ground truth for validating satellite retrievals and improving model simulations. Finally the validated satellite retrievals can be used to study other hydrological extremes over other climatic regions where the ground-based observations are not available.

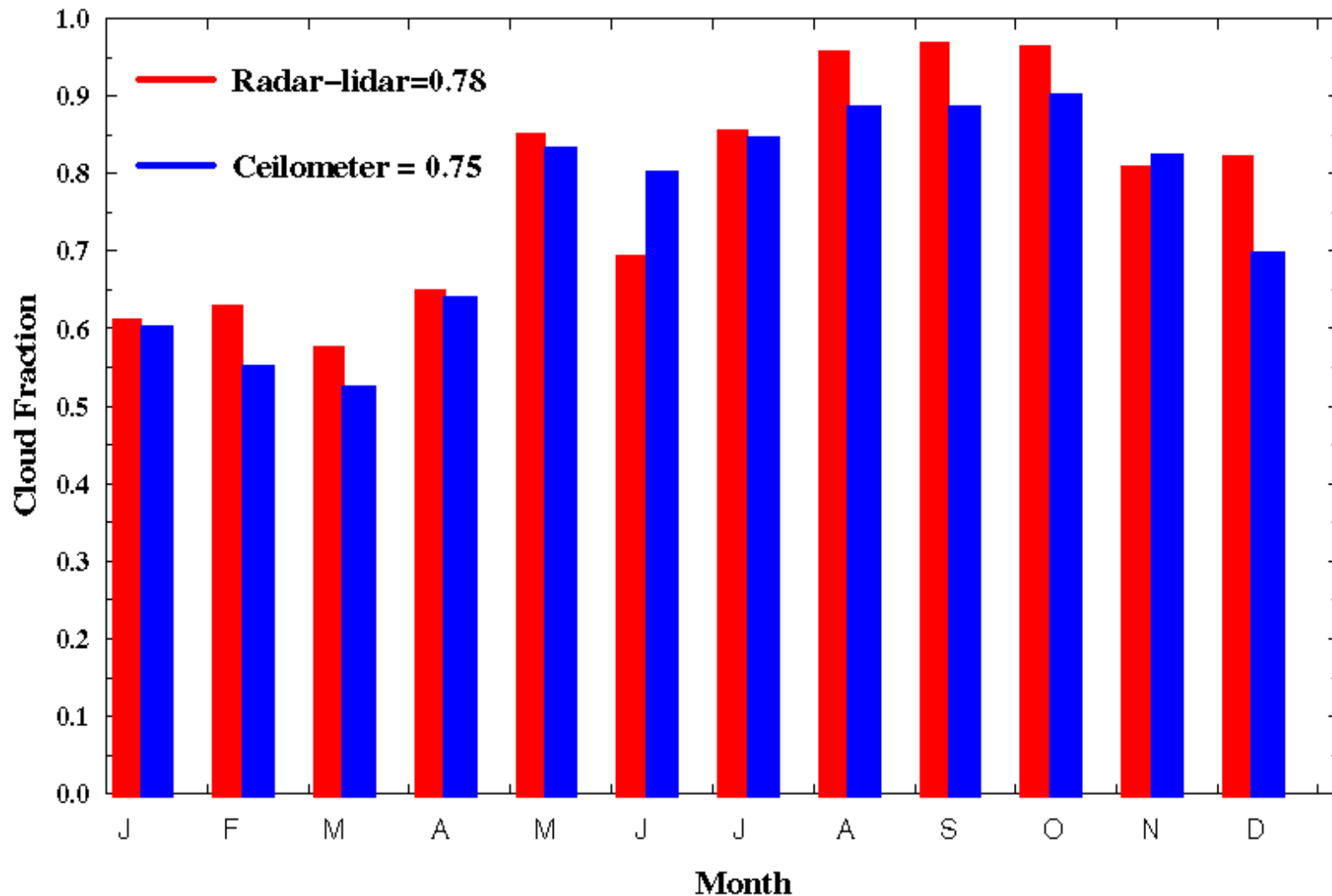# Goal 1: ARM ground-based cloud radiation and Precipitation Observations

1) **Three fixed ARM sites: SGP, NSA, and TWP since 1997.**

2) **ARM Mobile Facility (AMF) deployed at Monterey, CA (2005); Niamey, Niger (2006); Heselbach, Germany (2007); Shouxian, China (2008); and Azores (2009-2010).**

Comparison of total cloud fraction at the ARM SGP Site

This study=0.49
Warren et al. (1986)=0.50
Lazarus et al. (2000)=0.50
Minnis_GOES=0.48
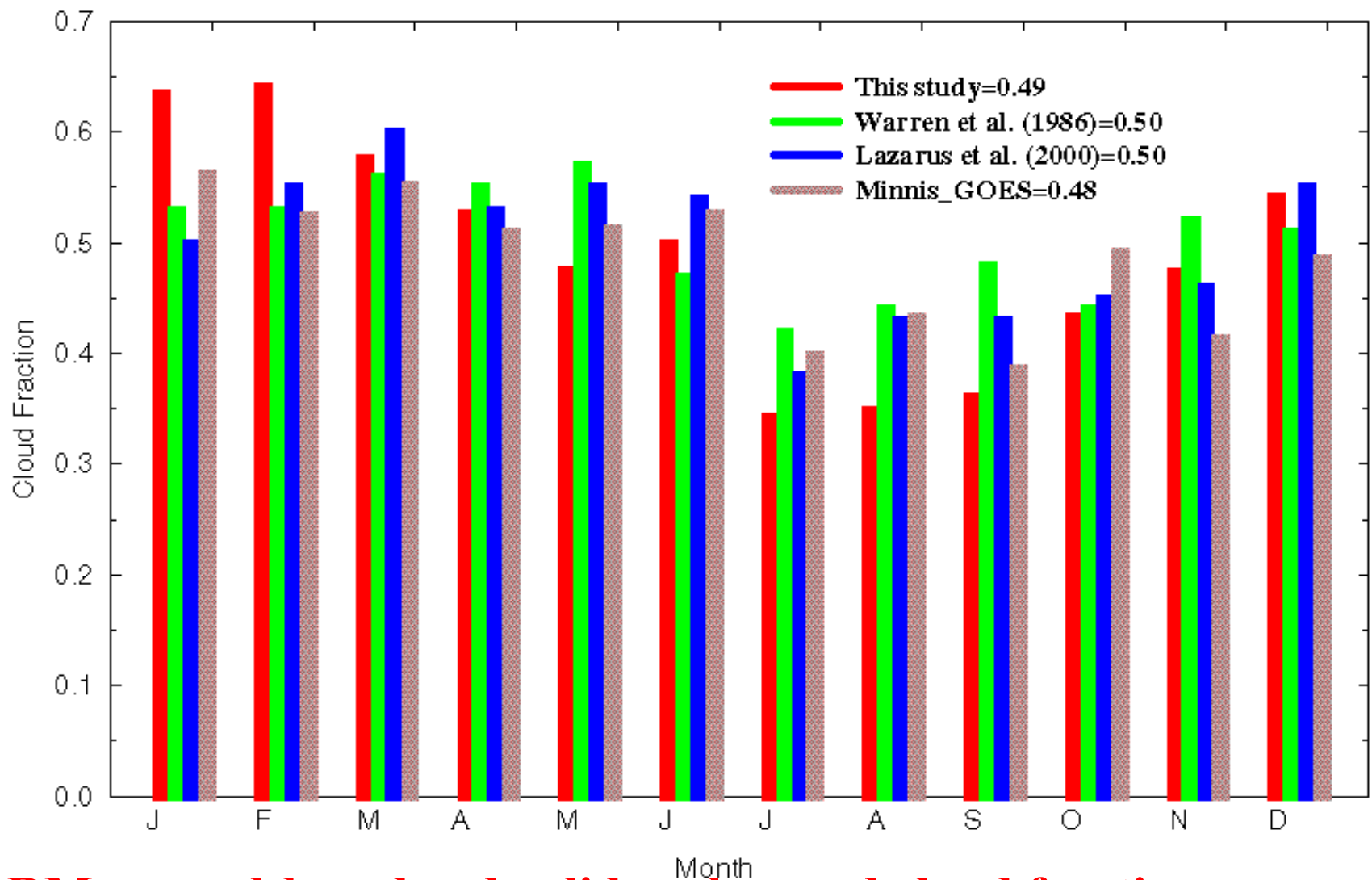
ARM ground-based radar-lidar observed cloud fractions agree well with GOES and surface human observations. Dong et al. 2005
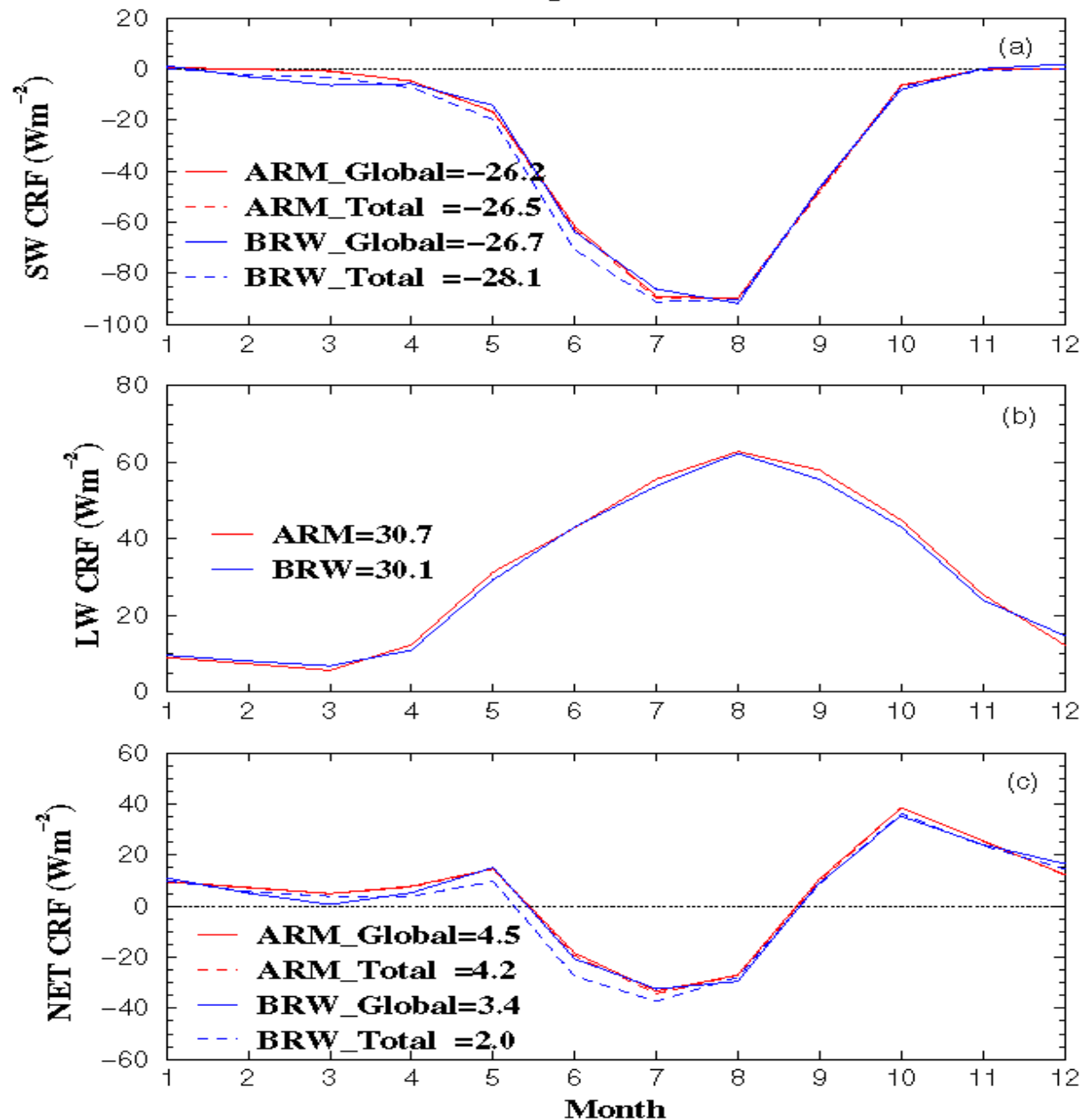
Monthly variations of cloud fraction at Barrow, Alaska

ARM ground-based radar-lidar observed cloud fraction at Barrow, Alaska

Dong et al. 2010

Arctic Cloud Radiative Forcings at Barrow, Alaska (06/1998–05/2008)

➔**Provide the seasonal variations of SW, LW, and NET CRFs over Barrow, Alaska.**
➔**On annual average, the negative SW CRFs and positive LW CRFs nearly cancel, resulting in annual average NET CRF of about 3.5 Wm⁻² .**

Goal 1: Other surface observations

- **Surface Precipitation from Oklahoma Mesonet Since 1997.**

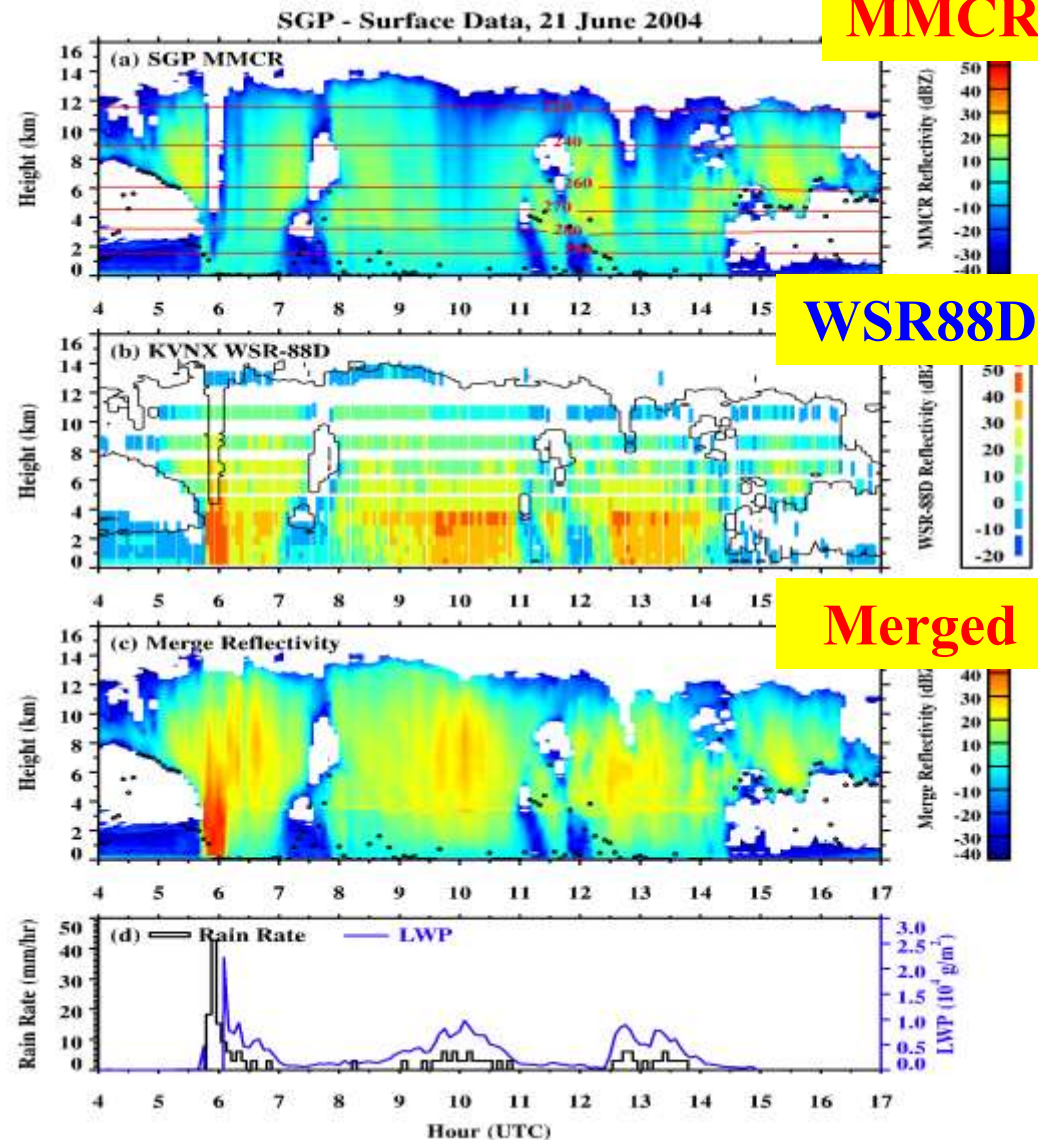- **WSR-88D NEXRAD observations over Oklahoma Site since 1997**
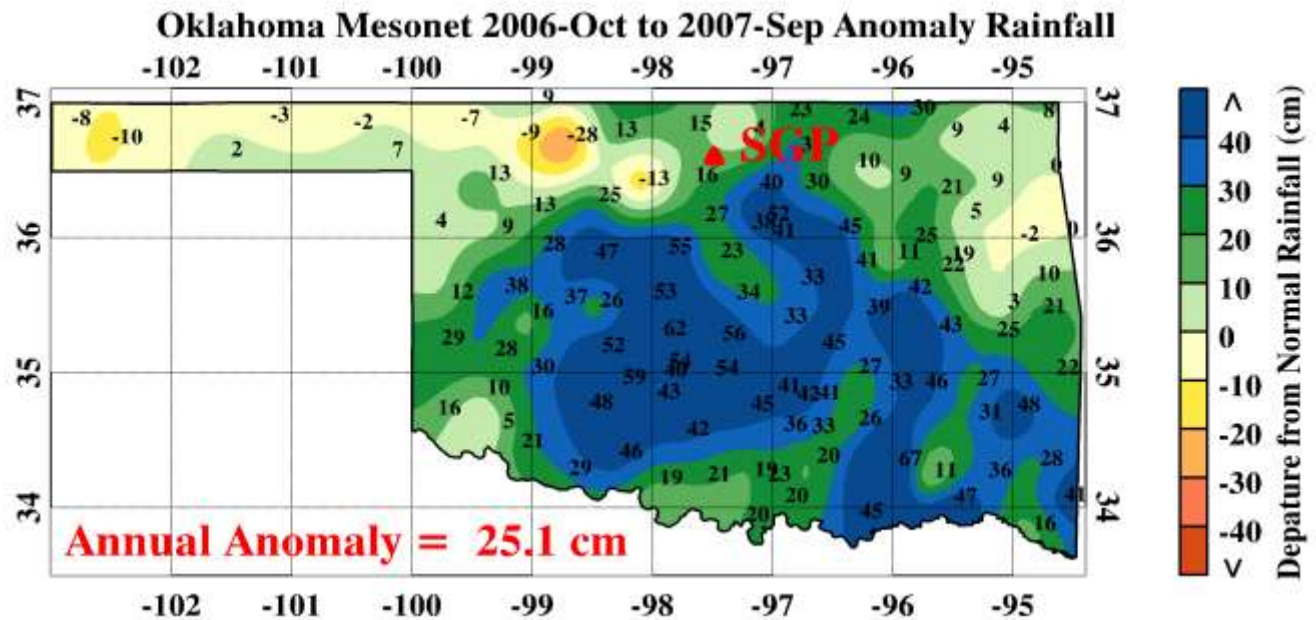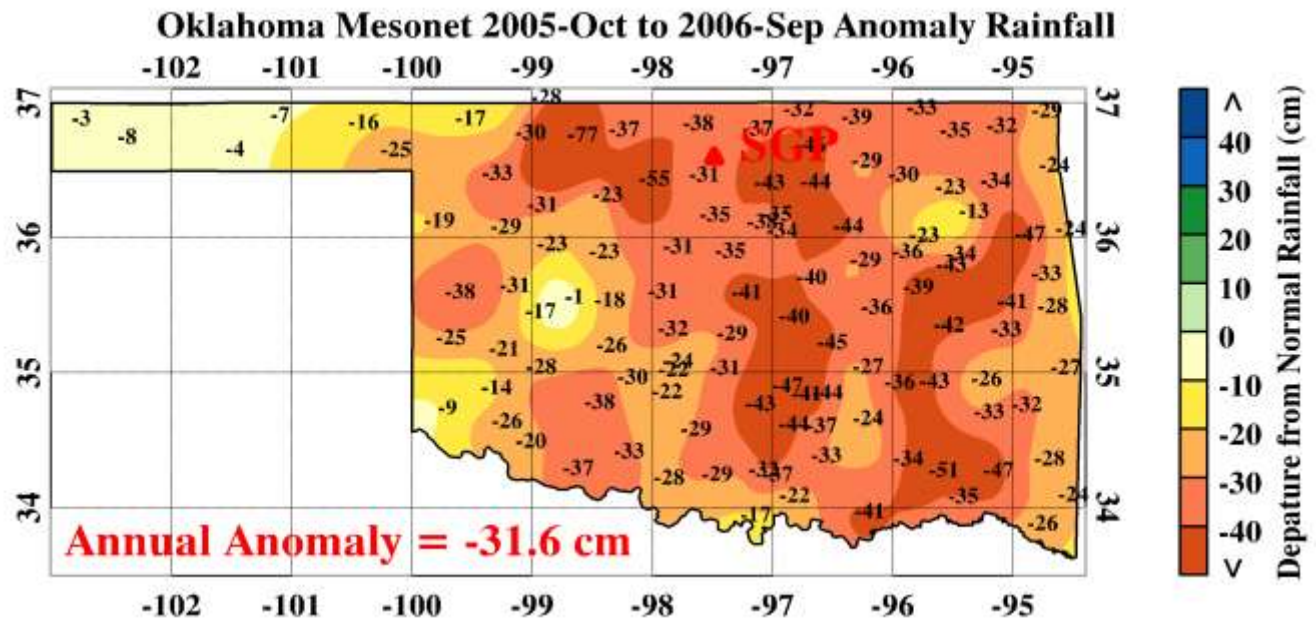
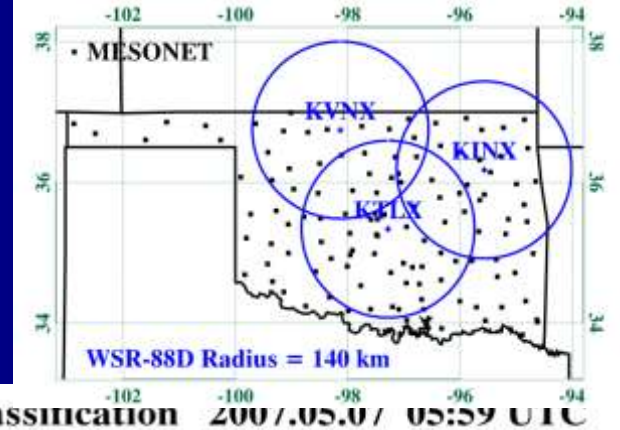**Precipitation distribution over OK during 2006 dry and 07 wet years**

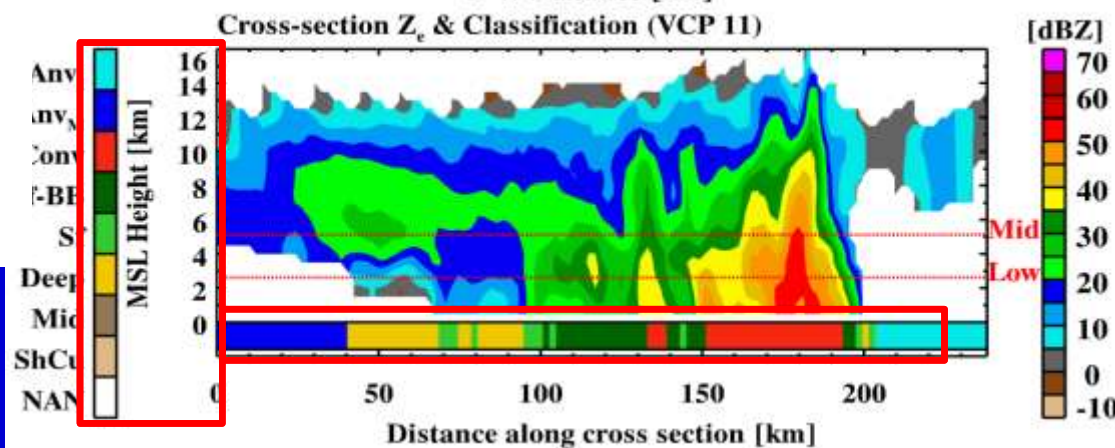# ARM PI Data Product over SGP site
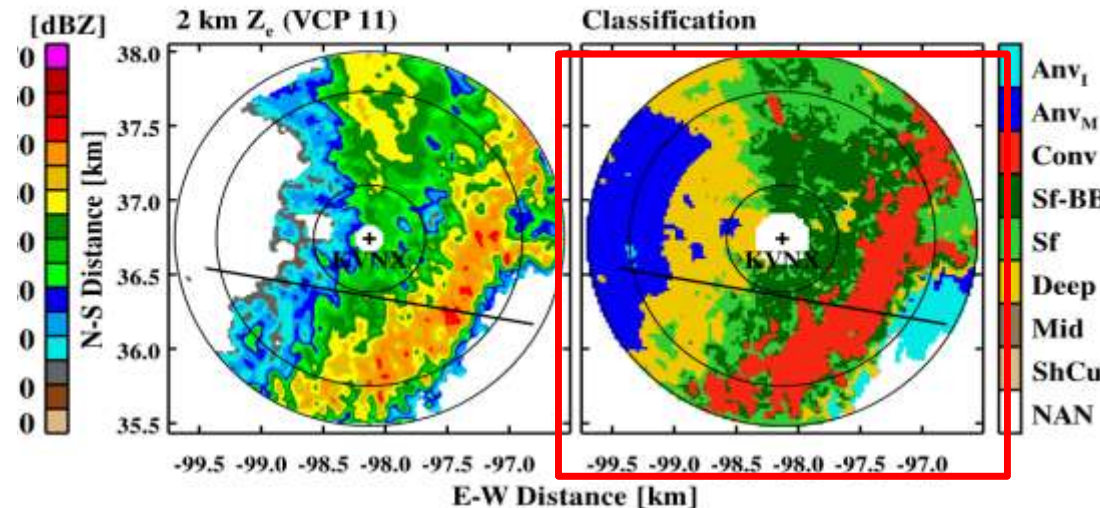## (Feng et al. 2009)

- **Merging ARM MMCR and WSR88D reflectivity to study deep convective events**

- **Corrected MMCR signal attenuation in deep convective clouds using Microwave Radiometer LWP**

- **Data period: 1997-2007**

SGP - Surface Data, 21 June 2004

MMCR

(a) SGP MMCR

WSR88D

(b) KVNX WSR-88D

Merged

(c) Merge Reflectivity

(d) Rain Rate — LWP

WSR-88D Data & Products (Feng et al. 2010)

- **3 WSR88D level 2 data in Oklahoma**

- **10 years (1997-2007), ~5min resolution**

- **Processed to 2x2x0.5-km 3D gridded reflectivity**
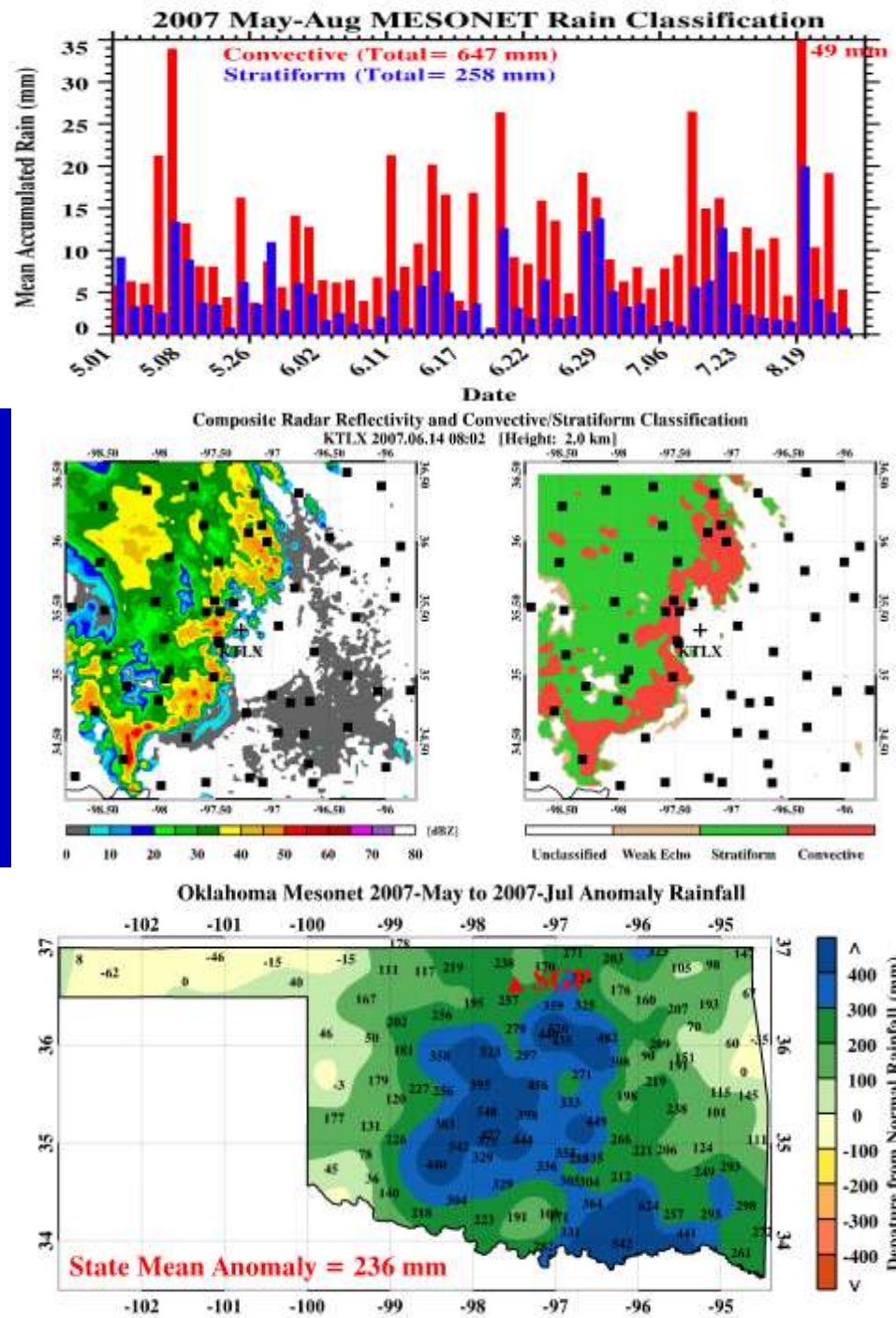
- **Algorithm to classify each radar grid to study:**

  a) Precipitation

  b) **Convective stratiform Cloud**

 c) ShCu **Deep Mix Ice Anvil**

# Oklahoma Mesonet

- **10-year surface rain gauge data (97-07)**

- **Rainfall classified into convective/stratiform by WSR88D**

- **Study precipitation climatology, extreme events, satellite retrieval validation**

2007 May-Aug MESONET Rain Classification

Convective (Total= 647 mm)
Stratiform (Total= 258 mm)

Composite Radar Reflectivity and Convective/Stratiform Classification
KTLX 2007.06.14 08:02 [Height: 2.0 km]

Oklahoma Mesonet 2007-May to 2007-Jul Anomaly Rainfall

State Mean Anomaly = 236 mm

WSR88D Mosaic

- **Classification using WSR88D Mosaic (NMQ)**
- **2009-current**
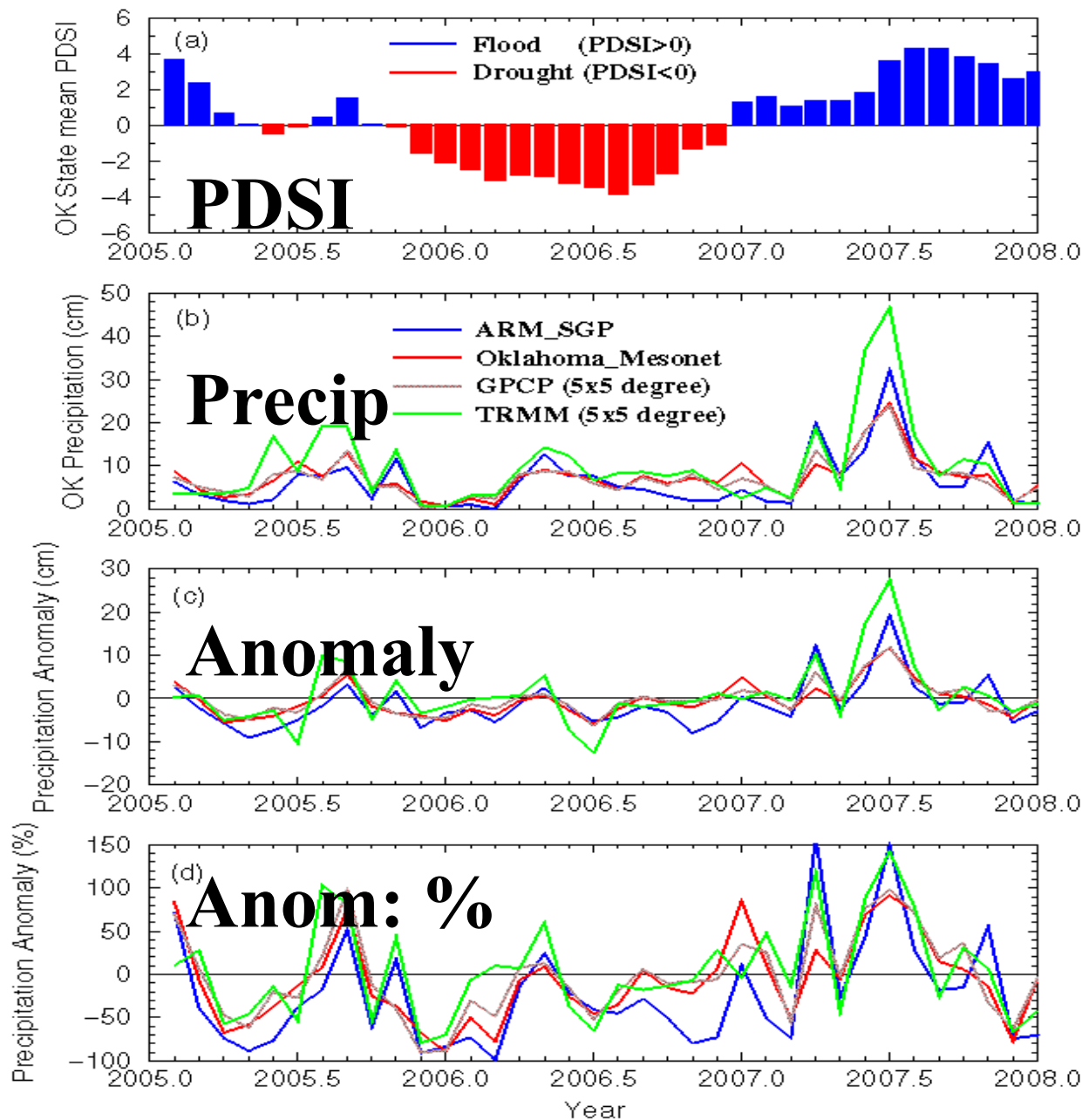- **Southern 8 states**
- **0.01°x0.01°, 31 level, 5-min**
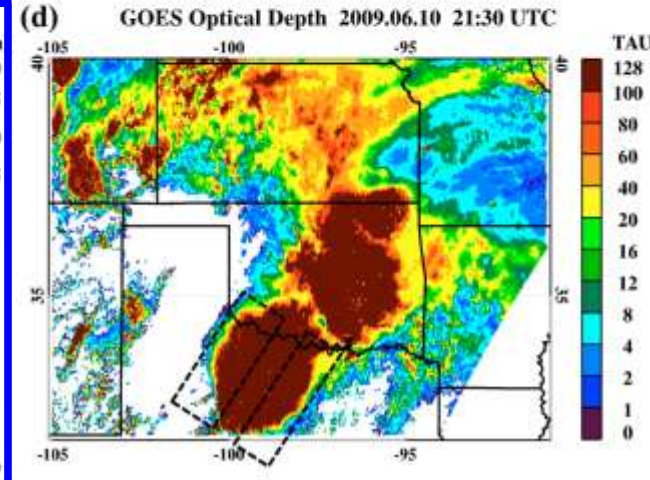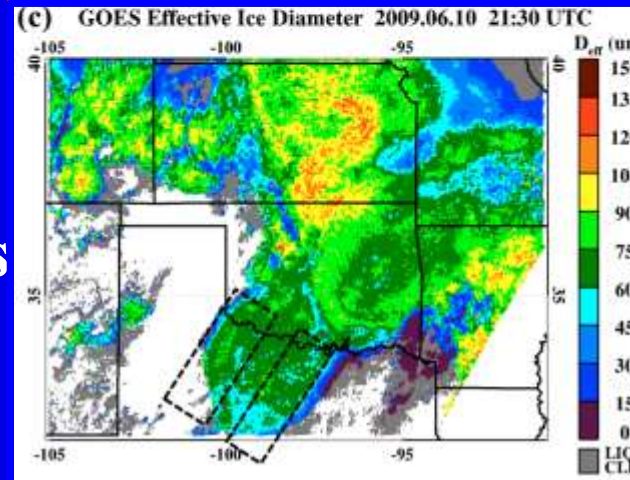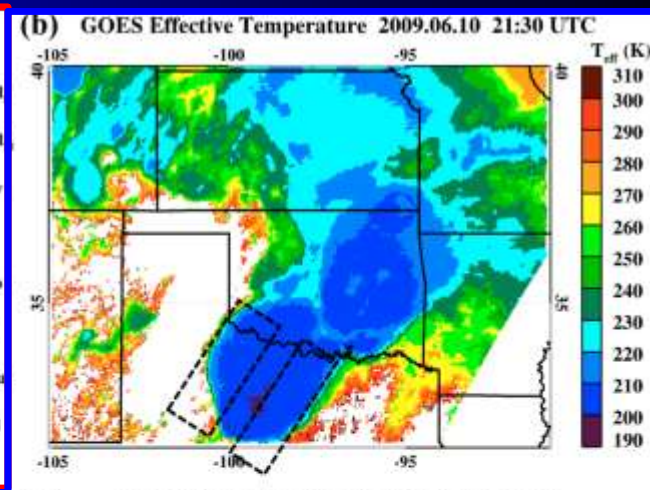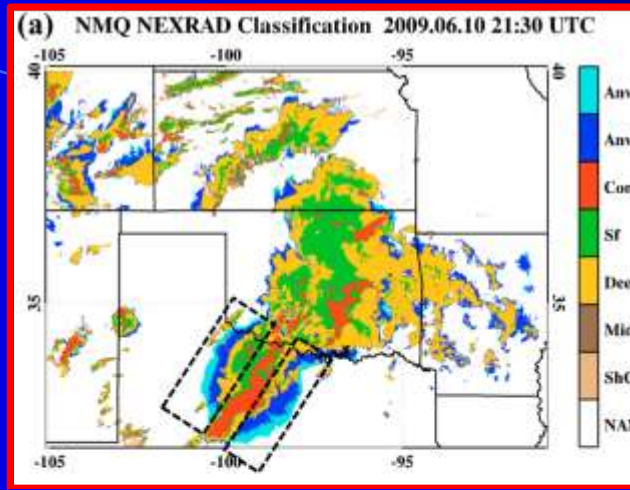
- Radar classification mapped with GOES microphysics (~30-min, Pat Minnis Group)
- Track deep convective systems and study the evolution of macro/micro-physical properties throughout the life cycle

Goal 2: Validating satellite retrievals and improving model simulations

1) Using the ground-based observations to validate the GPCP and TRMM precipitation

2) Using the ground-based observations to improve the WRF simulations and NCEP and MERAA reanalysis data sets.

PDSI and Precipitation over US Oklahoma State during 2005-2007

(a) **PDSI**
Flood   (PDSI>0)
Drought (PDSI<0)

(b) **Precip**
ARM_SGP
Oklahoma_Mesonet
GPCP (5x5 degree)
TRMM (5x5 degree)

(c) **Anomaly**

(d) **Anom: %**

➔ **The GPCP and TRMM retrieved precipitations agree well with ARM and OK mesonet observations.**

➔ **After build up confident to GPCP and TRMM data, then we can use them to study other hydrological events over other regions.**

Validation of WRF simulated convective system using NEXRAD

WRF

NEXRAD

20070524_0000 WRF classification
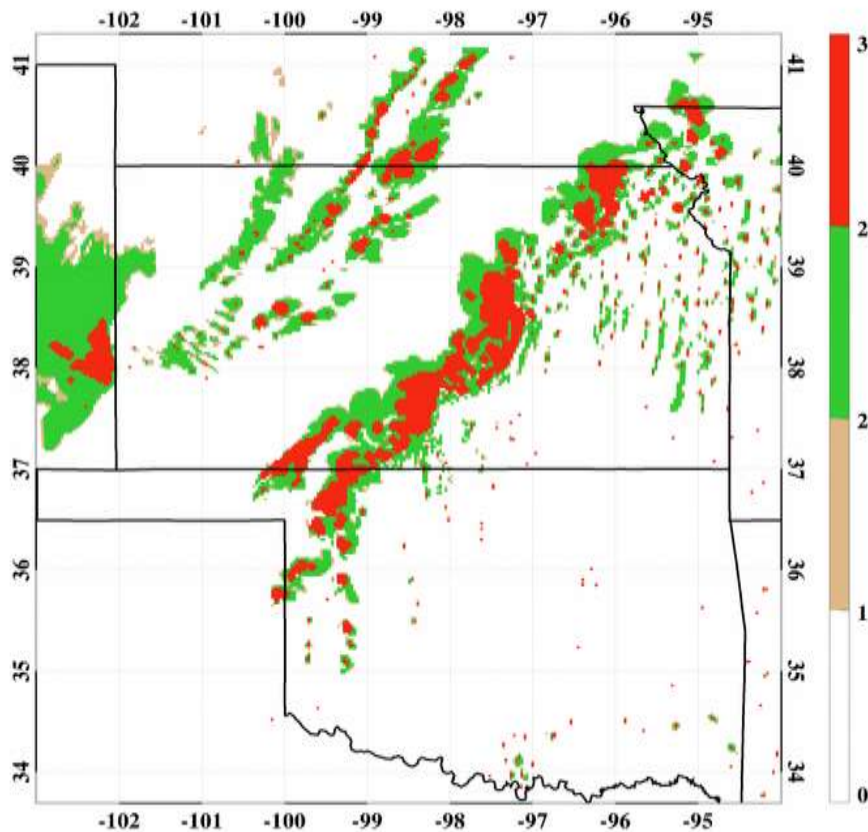
2007.05.24 00:00 Oklahoma Radar Classification
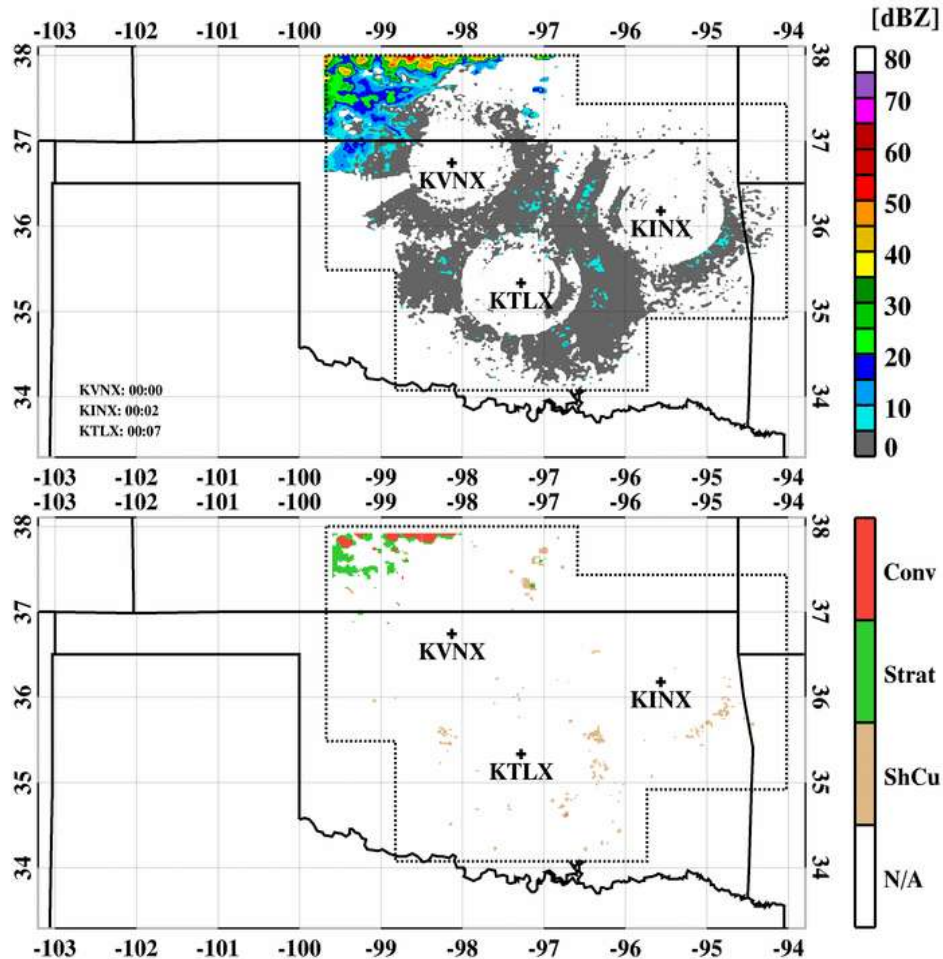
Validation of WRF and NARR simulated precipitation using OK Mesonet

Oklahoma State 3 Hourly Accumulated Precipitation
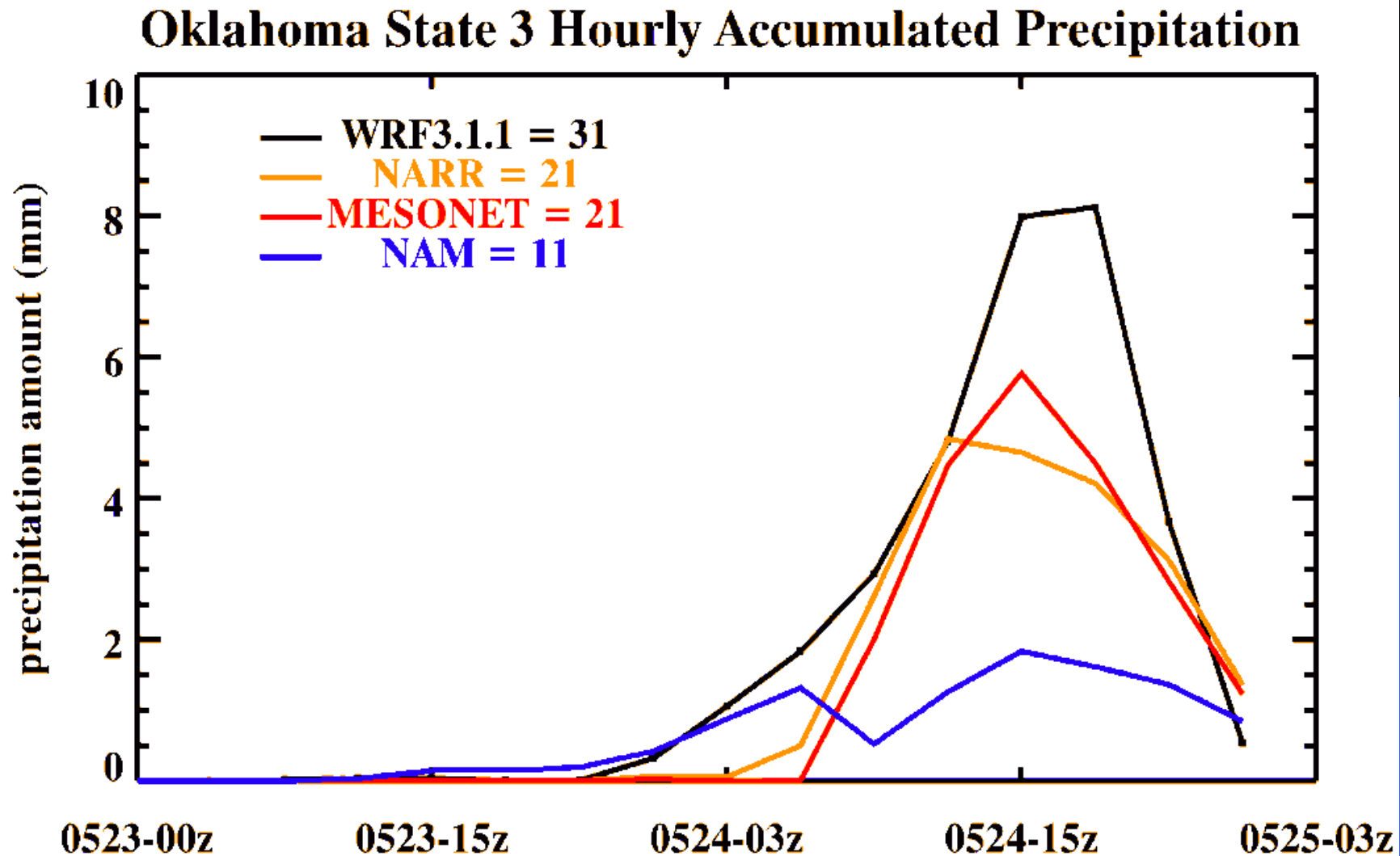
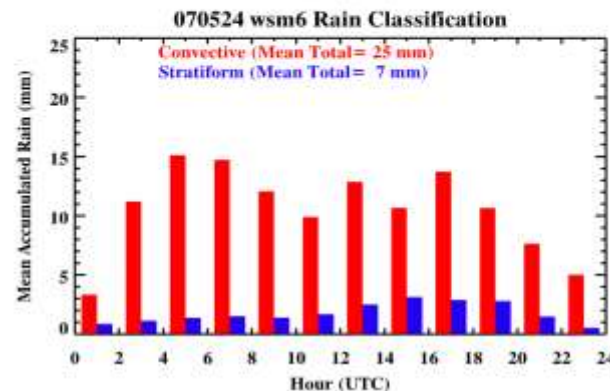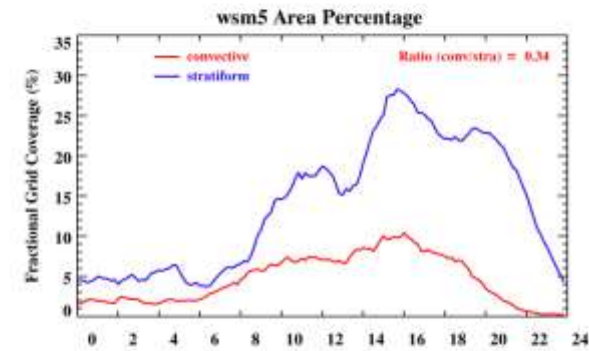# Validation of WRF cloud microphysics and precipitation using NEXRDA and OK mesonet
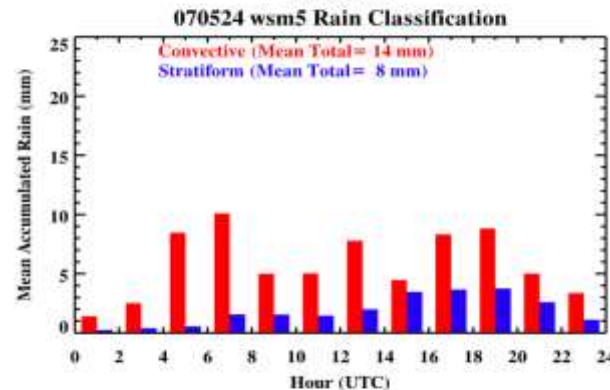
NEXRAD radar
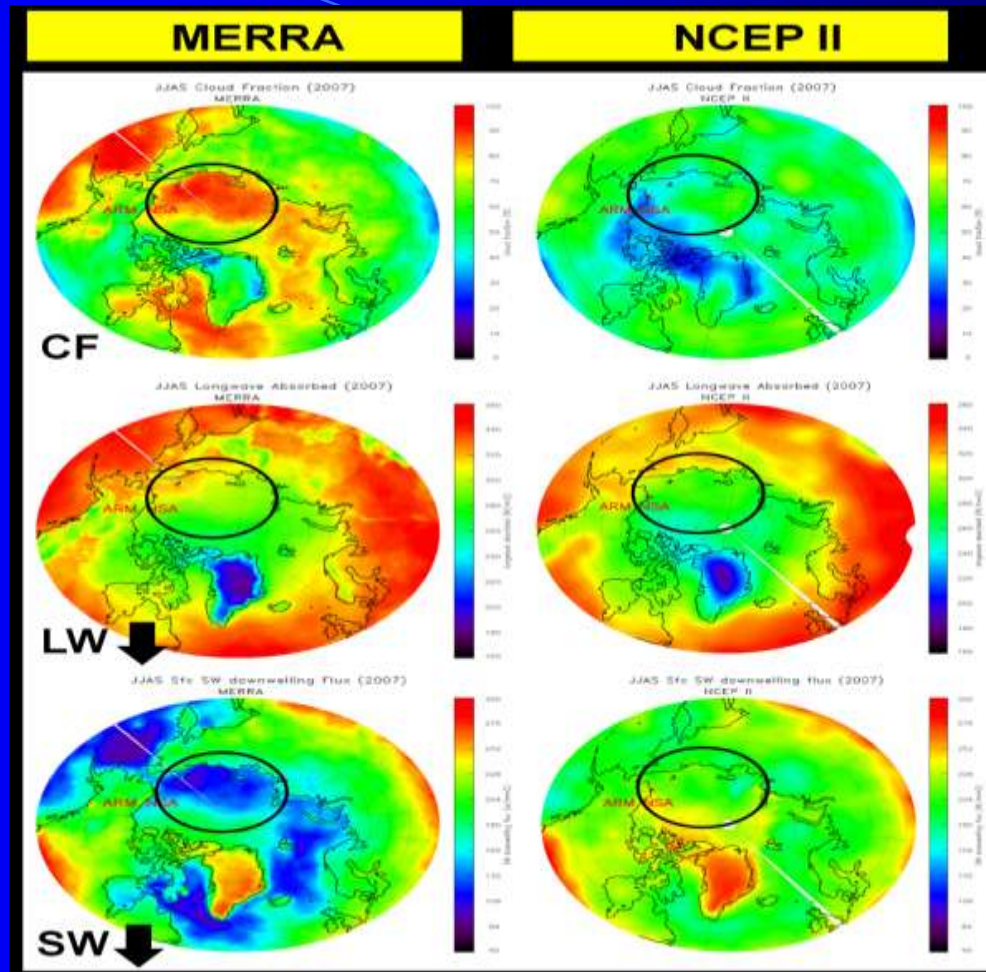- To separate convective and stratiform regions

Model
- For sensitivity test, using wsm5, and wsm6 microphysics schemes
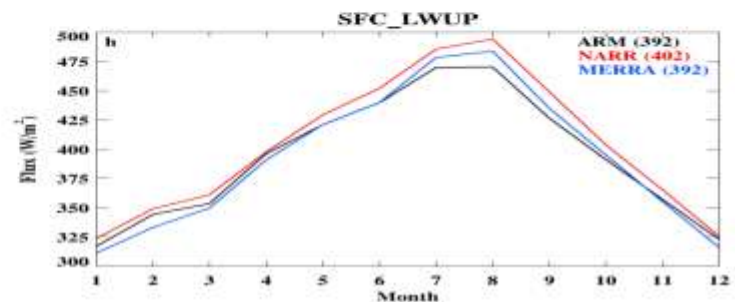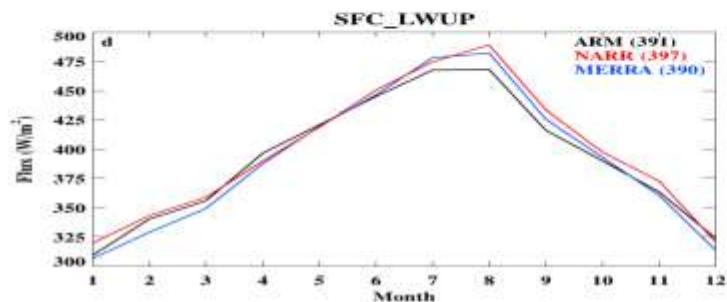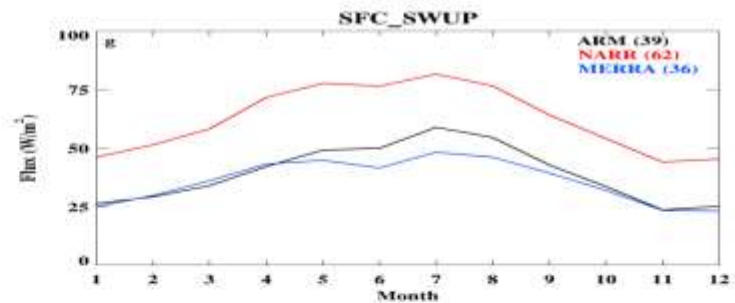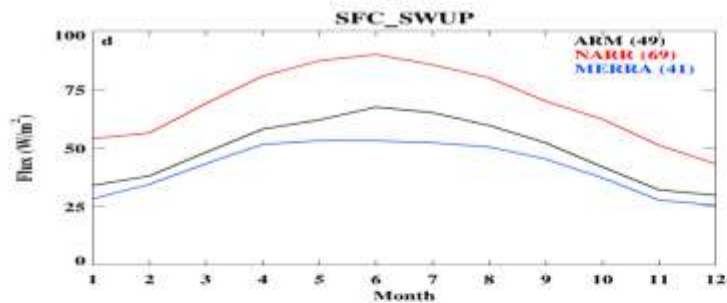
Mesonet rain gauge network
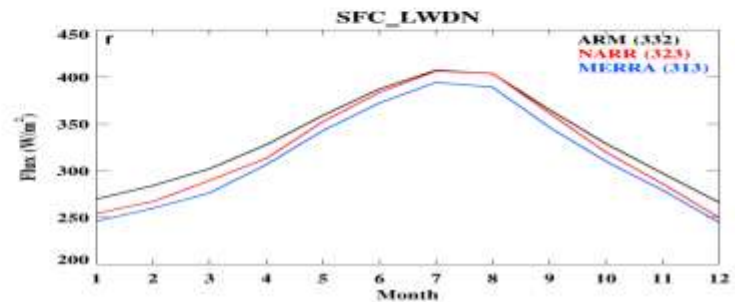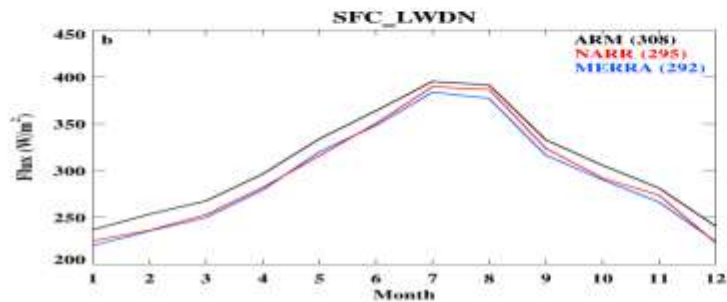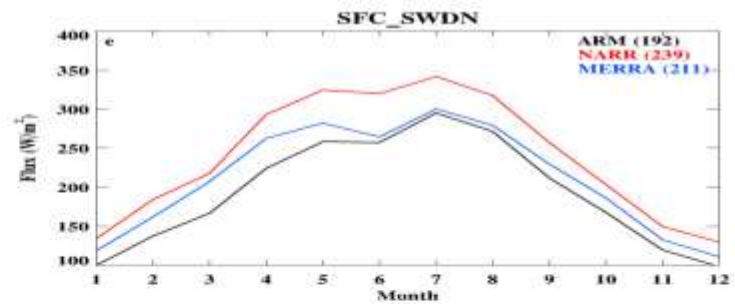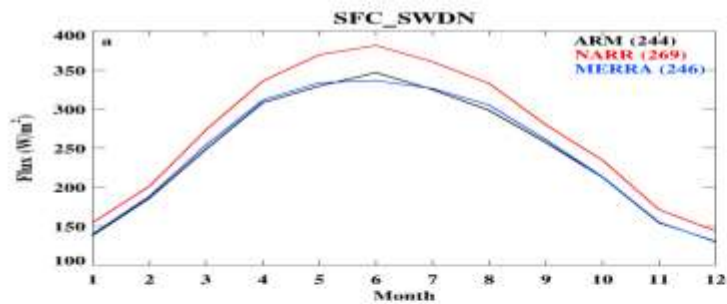- Provide ground truth for surface precipitation
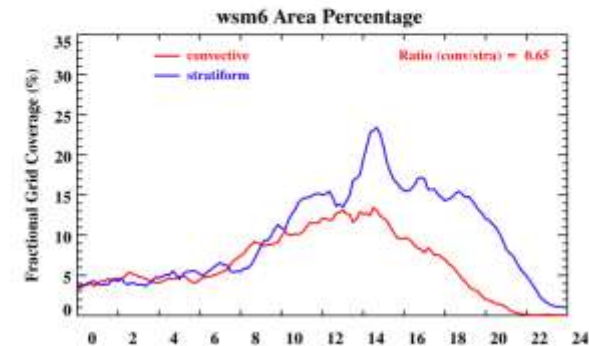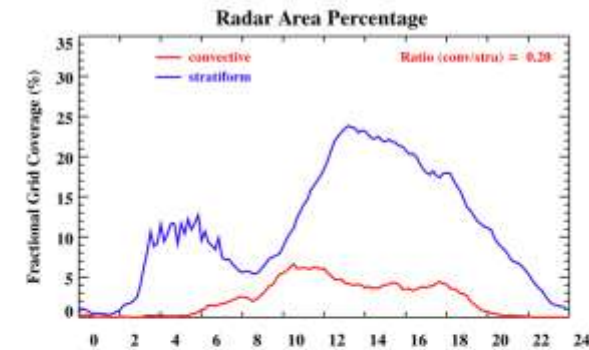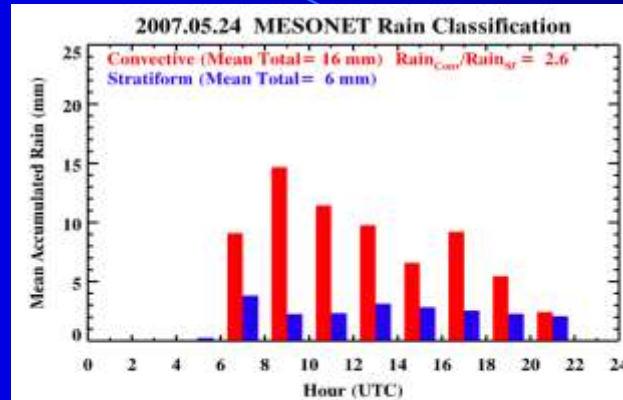
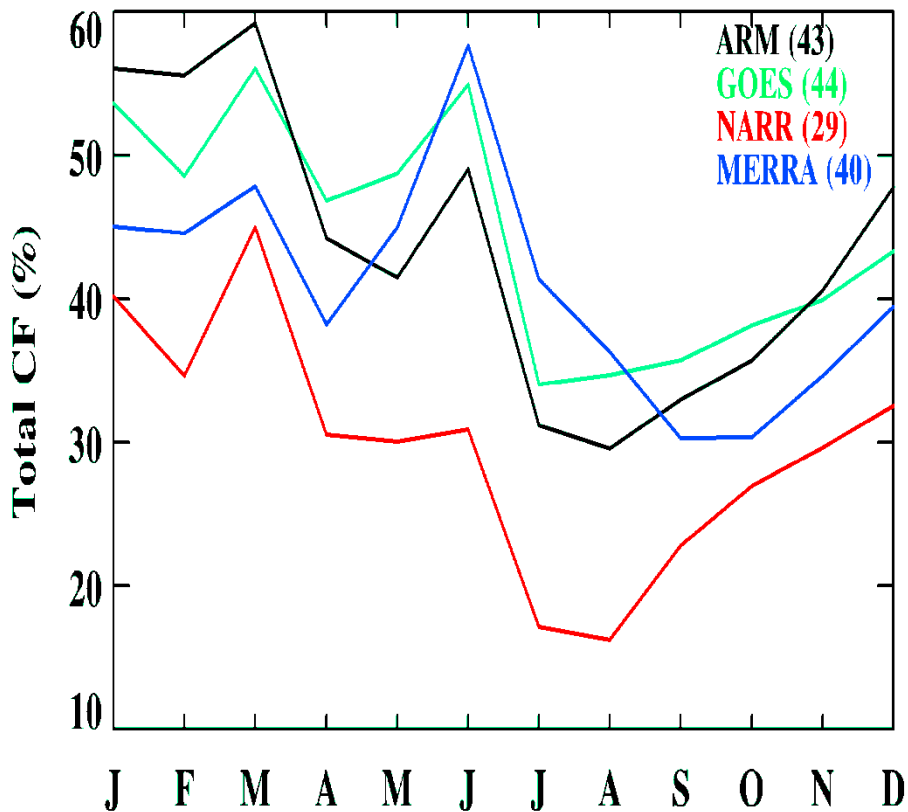# Validation of MERRA and NCEP reanalyses

The atmospheric state Variables are close to each other from two analyses. However, there are significant differences in cloud fraction, SW and LW fluxes.
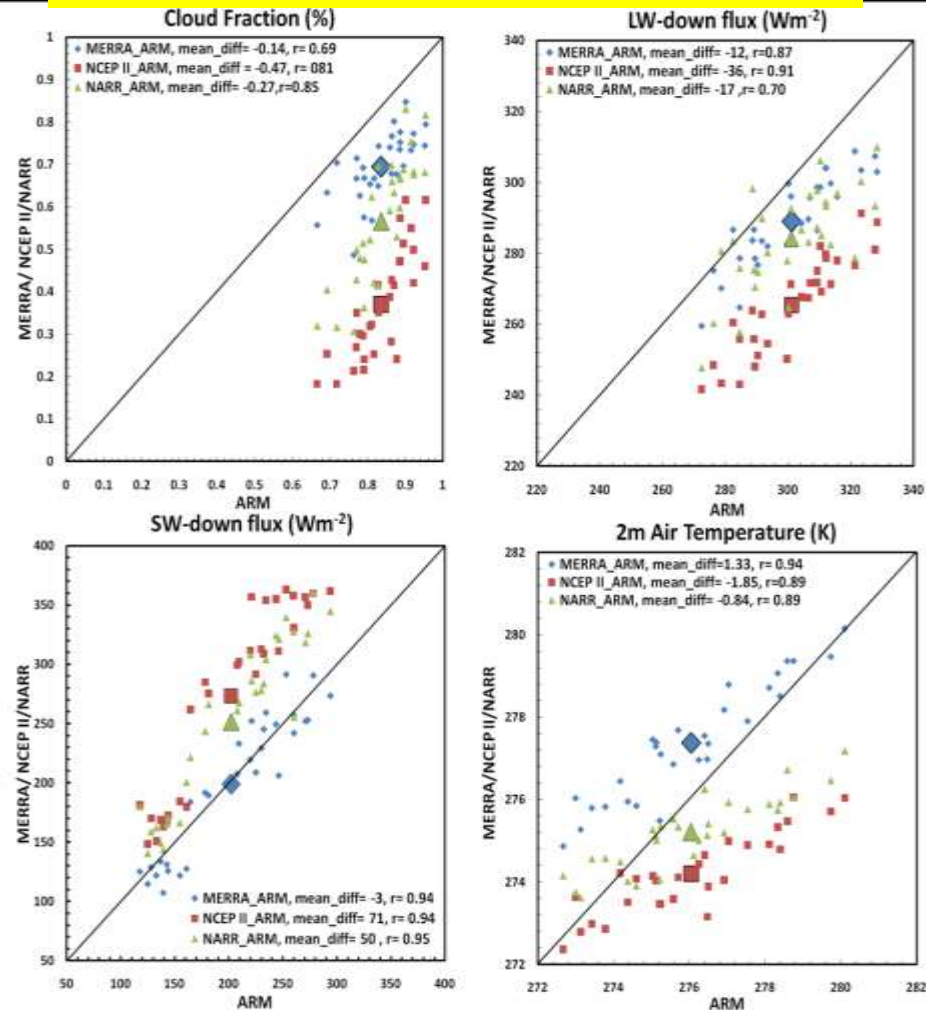
MERRA simulations agree with ARM SGP observations much better than NCEP simulations

CF comparison at SGP Comparisons at NSA

Comparisons between MERRA and NCEP with ARM SGP and NSA observations have shown that MERRA simulations agree much better than those from NCEP.

Other available data sets at UND

Name	Time Period	Location	Horizontal	Vertical	Temporal
NARR	1979-2009	North America	~32km	25-50 mb / 45 levels	3 hour
NCEP Global	1979-2009	Global	2.5x2.5	17 levels	6 hour
MERRA Atm. State	1999-2001	Global	1.25x1.25	42 levels	3 hour
MERRA Radiationn/Cloud/SFC	1999-2001	Global	1/2x2/3	Single Level	1 hour
NARR ARM SGP	1979-2009	ARM SGP	~180 km /2x2.5	NARR	NARR
MERRA ARM SGP	1999-2001	ARM SGP	~180 km / 2x2.5	MERRA	MERRA